The Printer Working Group

PDF Image-Streamable Format – “PDF/is”

(Formerly “PDFax”)

Working Draft for Proposed Standard 510n.y-0.6

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The Printer Working Group
PDF Image-Streamable Format (PDF/is)
Working Draft for Proposed Standard
510n.y-0.6

Abstract: This standard specifies a subset of PDF (Portable Document Format) 1.4 known as the PDF Image-Streamable Format (PDF/is) by formally defining a series of PDF/is "profiles" distinguished primarily by the method of image compression employed and color space used.
In summary PDF/is is an image document format intended for use by, but not limited to, the IPPFAX protocol, which is used to provide a synchronous, reliable exchange of image Documents between Senders and Receivers. PDF/is makes reference to the PDF 1.4 Reference [pdf], which describes the PDF representation of image data specified by the ITU-T Recommendations for black-and-white facsimile (see [t.4], [t.6]), the ISO/IEC Specifications for Digital Compression and Coding of Continuous-Tone Still Images (see [jpeg]), and Lossy/Lossless Coding of Bi-Level Images (see [jbig2]), and the general purpose Flate compression methods (see [rfc1950] and [rfc1951]).

This document is available electronically at:

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Title: The Printer Working Group Standard for PDF Image-Streamable Format

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1 Introduction

In summary, PDF/is is a raster image data format intended for use by, but not limited to, the IPPFAX protocol. IPPFAX is used to provide a synchronous, reliable exchange of image Documents between Senders and Receivers. PDF/is makes reference to the PDF 1.4 specification [pdf], which describes the PDF (Portable Document Format) representation of image data specified by the ITU-T Recommendations for black-and-white facsimile (see [t.4], [t.6]), the ISO/IEC Specifications for Digital Compression and Coding of Continuous-Tone Still Images (see [jpeg]), and Lossy/Lossless Coding of Bi-Level Images (see [jbig2]), and the general purpose Flate compression methods (see [rfc1950] and [rfc1951]). As an image-only format; text objects, line art, smooth shades, and the like are prohibited.

PDF/is is an image-only, streamable, subset specification of PDF 1.4 [pdf] and, as such, follows all of the specification requirements of PDF.

As a streamable version of PDF, it is not required that a Consumer of a PDF/is document be able to randomly access the PDF. The format has been adopted in such a way as to allow a Consumer the ability to read the PDF/is document from the beginning to end without the necessity to cache more data than is necessary to print the current page, or portion thereof, with some exceptions, as noted.

2 Terminology

This section defines terminology used throughout this document.

2.1 Conformance Terminology

Capitalized terms, such as **MUST, MUST NOT, REQUIRED, SHOULD, SHOULD NOT, MAY, NEED NOT, OPTIONAL,** and **PROHIBITED**, have special meaning relating to conformance as defined in RFC 2119 [rfc2119] and [rfc2911] section 12.1. If an implementation supports the extension defined in this document, then these terms apply; otherwise, they do not. These terms define conformance to *this document (and [rfc2911]) only*; they do not affect conformance to other documents, unless explicitly stated otherwise. To be more specific:

REQUIRED (REQ) - an adjective used to indicate that a conforming PDF/is Producer or Consumer's implementation MUST support the indicated operation, object, attribute, or attribute value. See [rfc2911] "Appendix A - Terminology for a definition of "support".

RECOMMENDED (REC) - an adjective used to indicate that a conforming PDF/is Producer or Consumer's implementation SHOULD support the indicated operation, object, attribute, or attribute value.

OPTIONAL (OPT) - an adjective used to indicate that a conforming PDF/is Producer or Consumer's implementation MAY support the indicated operation, object, attribute, or attribute value.

PROHIBITED (PROH) - an adjective used to indicate that a conforming PDF/is Producer or Consumer's implementation MUST NOT support the indicated operation, object, attribute, or attribute value.

IGNORED – an adjective used to indicate that a conforming PDF/is Producer or Consumer implementation NEED NOT support the indicated operation, object, attribute, or attribute value; but this feature MAY be added to a future version of this specification.

AS SPECIFIED – is used to indicate that a conforming PDF/is Producer or Render implementation MUST, MAY, or MUST NOT support the indicated operation, object, attribute, or attribute value as is defined in the indicated specification.

OR – a conjunction that specifies a logical 'or', implying that a choice of one or more of the choices specified.

XOR – a conjunction that specifies a logical 'exclusive or', implying that a choice of one and only one of the choices specified.

2.2 Other Terminology

The following terms are introduced and capitalized in order to indicate their specific meaning:

Implement – The specified feature is present in the Document.

Support – A Producer has the capability of Implementing the feature specified, or the Consumer has the capability of understanding and acting on the Implementation.

Document – The PDF/is-formatted electronic representation of a set of one or more pages that the Sender sends to the Receiver.

Consumer – This is the agent (software, hardware or some combination) that converts the Document into a displayed or printed form.

Producer -- This is the agent (software, hardware or some combination) that creates the Document.

Interpolation – See 'Interpolation' in [pdf] pg. 273.

Forward-Reference – In indirect object reference (See [pdf] Section 3.2.9) to an object that appears later in the Document.

Cache – Consumer's storage, either memory, disk, or the like, to hold Document data as it's received from the Producer.

Page-Relative Objects – Objects that are indirectly referenced (See [pdf] Section 3.2.9) by either a 'Page' object or through a chain of object references that start with a reference from a 'Page' object.

Discarded – An adjective that describes a PDF object. An object is 'Discarded' when the Consumer no longer has access to the data within the object in question.

Object Size – The number of bytes required to represent an object in the Document. The size is calculated by subtracting the offset of the first byte of the line following the "endobj" of the object in question, from the offset of the first byte of the *object number* (See [pdf] Section 3.2.9).

3 PDF/is Support

3.1 Profiles

The following sections define the profile names used later in the document. Full specification of each profile will occur later in the specficiation.

3.1.1 Image Profiles

The following table defines the Profile names used to describe various image compression filters and techniques.

Table 3-1: Image Profiles

Profile	Image Implementation	Reference
<MASK>	'Masked Images' and/or 'Tiling'	[pdf] Section (4.8.5) and "The Tiling Operator:" Section of this specification.
<JP2K>	JPEG2000 Filter	To be supported in a future version of PDF/is.

For a Producer to be considered to support the <MASK> Profile, 'Masked Images' OR 'Tiling' MUST be Supported. For a Consumer to be considered to support the <MASK> Profile, 'Masked Images' and 'Tiling' MUST be Supported.

3.1.2 Security Profiles

There are several options that MAY be Supported by a Producer or Consumer with regard to security:

Table 3-2: Security Profiles

Profile	Security Implementation	Reference
<STD-ENC>	'Standard' Encryption	[pdf] Section 3.5.2
<PPK-ENC>	PPK Encryption	[pdf-ppk] Section 3
<DIG-SIG>	Digital Signature	[pdf-ppk] Section 2.2

3.2 PDF Document Requirements

For the table shown below, a Consumer MUST Support all aspects of the object/filter (as defined in the Field Specification, below) for the object/filter to be considered Supported. A Producer NEED NOT Support more aspects of the object/filter than are Required of the object/filter (as defined in the Field Specification) for the object/filter to be considered Supported.

Key:

Producer: Producer Requirement.

320 **Consumer**: Consumer Requirement.

321 **Table 3-3: PDF Object Requirements**

PDF Object/Filter	Producer	Consumer	Reference
'ASCIIHexDecode' Filter	PROH	PROH	[pdf] Section (3.3.1)
'ASCII85Decode' Filter	PROH	PROH	[pdf] Section (3.3.2)
'LZWDecode' Filter	PROH	PROH	[pdf] Section (3.3.3)
'RunLengthDecode' Filter	PROH	PROH	[pdf] Section (3.3.4)
Incremental Updates	PROH	PROH	[pdf] Section (3.4.5)
Functions	PROH	PROH	[pdf] Section (3.9)
Files	PROH	PROH	[pdf] Section (3.10)
Graphics State Parameter Dictionaries	PROH	PROH	[pdf] Section (4.3.4)
Path objects	PROH	PROH	[pdf] Section (4.4)
'DeviceGray' Color Space	PROH	PROH	[pdf] Section (4.5.3)
'DeviceRGB' Color Space	PROH	PROH	[pdf] Section (4.5.3)
'DeviceCMYK' Color Space	PROH	PROH	[pdf] Section (4.5.3)
Pattern Color Space	PROH	PROH	[pdf] Section (4.5.5)
Separation Color Space	PROH	PROH	[pdf] Section (4.5.5)
DeviceN Color Space	PROH	PROH	[pdf] Section (4.5.5)
Pattern Objects	PROH	PROH	[pdf] Section (4.6)
Inline Image Objects	PROH	PROH	[pdf] Section (4.8.6)
Form Xobjects	PROH	PROH	[pdf] Section (4.9)
Postscript Xobjects	PROH	PROH	[pdf] Section (4.10)
Text Objects	PROH	PROH	[pdf] Section (5)
Transparency	PROH	PROH	[pdf] Section (7)
'CCITTFaxDecode' Filter	REQ	REQ	[pdf] Section (3.3.5)
File Header	REQ	REQ	[pdf] Section (3.4.1)
Cross-Reference Table	REQ	REQ	[pdf] Section (3.4.3)
File Trailer	REQ	REQ	[pdf] Section (3.4.4)
Document Catalog	REQ	REQ	[pdf] Section (3.6.1)
Page Tree Nodes	REQ	REQ	[pdf] Section (3.6.2)
Page Objects	REQ	REQ	[pdf] Section (3.6.2)
Content Streams	REQ	REQ	[pdf] Section (3.7.1)
Resource Dictionaries	REQ	REQ	[pdf] Section (3.7.2)
Image XObjects	REQ	REQ	[pdf] Section (4.8)
'FlateDecode' Filter	OPT	REQ	[pdf] Section (3.3.3)
'JBIG2Decode' Filter	OPT	REQ	[pdf] Section (3.3.6)
'DCTDecode' Filter	OPT	REQ	[pdf] Section (3.3.7)
Encryption Dictionary 'Standard' Encryption (Security Profile <STD-ENC>)	OPT	OPT	[pdf] Section (3.5)
Encryption Dictionary PPK Encryption (Security Profile <PPK-ENC>)	OPT	OPT	[pdf-ppk] Section (3)
'DeviceGray' Color Space	PROH	PROH	[pdf] pg. 182, See "ICCBased Color Space" section of this specification.
'DeviceRGB' Color Space	PROH	PROH	[pdf] pg. 184, See "ICCBased Color Space" section of this specification.
'Lab' Color Space	PROH	PROH	[pdf] pg. 187
'ICCBased' Color Space	REQ	REC	[pdf] pg. 189

'Indexed' Color Space	PROH	PROH	[pdf] pg. 199
Masked Images (Image Profile <MASK>)	OPT	OPT	[pdf] Section (4.8.5)
Interactive Form Dictionary and Annotation Field Dictionary and Signature Dictionary (Security Profile <DIG-SIG>)	OPT	OPT	[pdf] Section (8.6.1-3) [pdf-ppk] Section (2)
Cached Objects	REQ	REQ	Section 3.4
Tiling (Image Profile <MASK>)	OPT	OPT	Section 3.3.11.3

NOTE: JBIG2Decode Filter may be made Optional for the Consumer in a later revision of this specification if it is determined that decoding JBIG2 images is burdened by Intellectual Property.

3.3 PDF Object Requirements

The following sub-sections describe the object field values of the REQUIRED and OPTIONAL PDF objects in PDF/is. The numbers in '( )'s refer to section numbers in the PDF Specifications [pdf], unless otherwise noted. 'AS SPECIFIED' refers to the PDF Specification [pdf] unless otherwise noted.

All 'Required' and 'Optional' fields of a Document object (either specified here or referred to as 'Required' or 'Optional' in [pdf] or [pdf-ppk]) MUST be Supported if the object in question is to be considered 'Supported by the Consumer'. This rule does not apply if the definition of an object specifically states the requirement for the Consumer.

All 'Required' fields of a Document object (either specified here or referred to as 'Required' in [pdf] or [pdf-ppk]) MUST be Supported if the object in question is to be considered 'Supported by the Producer'. All object referred to as 'Optional' are Optional for the Producer. This rule does not apply if the definition of an object specifically states the requirements for the Producer.

3.3.1 'PDF/is' object

A new 'PDF Name Registry' (See [pdf] – Appendix E) object that is REQUIRED for a PDF/is document. The existence of this dictionary object is the one and only way to determine if the PDF in question is a PDF/is. The references in this object to items referred to in the Document Trailer are necessary to satisfy 'Producer Requirement' #6, see Section 4.1.

Table 3-4: PDF/is Object

Field	Type	Specification
'Type'	Name	MUST have a value of '/Fis_PDFis'.
'Fis_Profiles'	Array of Numeric Objects	REQUIRED: An array consisting of [**MAJ_VER MIN_VER IMAGES SECURITY MEMORY**]
'Encrypt'	Dictionary	MUST have same value as 'Encrypt' field in the 'Document Trailer'. See [pdf] table 3.12 for specification.
'Root'	Dictionary	MUST have same value as 'Root' field in the 'Document Trailer'. See [pdf] Table 3.12 for specification.
'Info'	Dictionary	MUST have same value as 'Info' field in the 'Document Trailer'. See [pdf] Table 3.12 for specification.
'ID'	Array	MUST have same value as 'ID' field in the 'Document Trailer'. See [pdf] Table 3.12 for specification.
'Fis_NextPage'	Dictionary	REQUIRED: An Indirect Object Reference to the first 'Page' object.

See [pdf] Section 3.2.5 for definition of an 'Array Object'. See [pdf] Section 3.2.2 for definition of a 'Numeric Object'.

3.3.1.1 Fis_Profiles Key

3.3.1.1.1 MAJ_VER:

The 'major' version number of this PDF/is specification to which the Producer conforms to at the time the Document was created. The 'major' version of this specification is currently '0'.

3.3.1.1.2 MIN_VER:

The 'minor' version number of this PDF/is specification to which the Producer conforms to at the time the Document was created. The 'minor' version of this specification is currently '6'.

3.3.1.1.3 IMAGES, SECURITY:

Each value in the array MUST be a 'Numeric Integer Object' (See [pdf] Section 3.2.2) that is the sum of all of the Integer equivalents of the binary 'Bit Positions' for the Profiles that are Implemented in the Document, as indicated under the appropriate section below. The 'Bit Positions' are numbered from 1 (low-order) to 32 (high-order). A '1' in a 'Bit Position' indicates the Profile in indicated. All other Bit Positions for each element MUST be 0.

For example, to indicate that the SECURITY Profiles <STD-ENC> (bit position 1 or the value 1) and <DIG-SIG> (bit position 3, or 100 binary), the value of '5' (101 binary) should be used as the value for the 'SECURITY' field.

The Producer of the Document MUST NOT Implement a Profile that is not indicated in this field. The Producer of the Document MAY Implement all Profiles indicated in this field, but is NOT REQUIRED.

> Rationale: Since this object must be located at the beginning of the Document, it may not be known for certain which Profiles will be Implemented. This field is an advisory indicator to a Consumer as to which features MAY be present in the Document. If all Profiles indicated are not Supported, the Document may still be rendered if a non-Supported Profile is indicated but is not actually Implemented in the Document.

Table 3-5: PDF/is Object 'IMAGES' Element

Profile	Bit Position
<MASK>	1
<JP2K>	2

Table 3-6: PDF/is Object 'SECURITY' Element

Profile	Bit Position
<STD-ENC>	1
<PPK-ENC>	2
<DIG-SIG>	3

3.3.1.1.4 MEMORY:

A 'Numeric Object' that is the decimal value of the minimum amount of cache memory the Consumer will need to cache all objects necessary to render any particular page or Tile (See "Tiling"). This memory MUST be available for PDF/is data file caching and MUST not be part of any image processing or page buffer memory.

The value specified for 'MEMORY' is in Kilobytes (1,024 bytes) and is in addition to a base memory requirement of 2 Megabytes (2,097,152 bytes).

The value used should specify the minimum cache memory that is available to either the Producer or Consumer, i.e. if the Consumer has 3 Megabytes of cache memory and the Producer has only 2 Megabytes, 2 Megabytes is the value that should be specified.

At the end of generation of each Indirect Object (See [pdf] Section 3.2.9), the Producer MUST ensure that this cache memory limit has not been exceeded. If the limit has been exceeded, the Producer MUST either reorganize the current page by using "Tiling", freeing up some "cached" objects, or by using some other process, in order to avoid breaking the cache buffer limit.

Calculation of the current cache buffer size MUST follow the following formula:

1) The current total Document size (in bytes) that has been created up to the point at which this calculation is being made.
2) Minus the 'Object Size' of all released 'Cached' objects (See "Cached Objects" Section of this specification), up to that point.
3) Minus the 'Object Size' of all non-cached 'Page-Relative Objects' for previous pages, not already accounted for by #2.
4) Minus the 'Object Size' of all non-cached 'Image XObjects' or 'Color Space' data for any previous 'Tiles' on the current page; if the page is "Tiled".
5) Minus the 'Object Size' of the last 'Image XObject' in the current 'Tile', if the page is "Tiled".
6) Minus the 'Object Size' of the 'Image XObject' for the current page, if the page is not "Tiled".

Rationale: The last two items assume that the Consumer will process image data as it is received and will not need to cache these objects before rendering.

3.3.1.1.5 Example

An example of the PDF/is object for a Document containing a ICCBased color JPEG image that's Standard encrypted (Profile <STD-ENC>) and needs a 4 Megabyte cache would look like this:

```
1 0 obj
<<
        /Fis_Profiles [0 6 0 1 2048]
        /Encrypt 2 0 R
        /Root 3 0 R
        /Info 4 0 R
        /Fis_NextPage 5 0 R
>>
endobj
```

3.3.2 'FlateDecode' Filter

See [pdf] Section 3.3.3, [rfc1950], and [rfc1951].

Table 3-7: FlateDecode Filter

Field	Specification
<All Fields>	AS SPECIFIED

3.3.3 'CCITTFaxDecode' Filter

See [pdf] Section 3.3.5, [t.4], and [t.6]. Note that only Group 4 images are Supported by PDF/is, see 'K', below.

Table 3-8: CCITTFaxDecode Filter

Field	Specification
'K'	MUST have a value of -1.
'EndOfLine'	AS SPECIFIED
'EncodedByteAlign'	AS SPECIFIED
'Columns'	AS SPECIFIED
'Rows'	AS SPECIFIED
'EndOfBlock'	AS SPECIFIED
'BlackIs1'	AS SPECIFIED
'DamagedRowsBeforeError'	AS SPECIFIED

3.3.4 'JBIG2Decode' Filter

See [pdf] Section 3.3.6, [jbig2], and [t.89].

Table 3-9: JBIG2Decode Filter

Field	Specification
<All Details>	AS SPECIFIED, except as noted below.

- The Producer MUST Implement only JBIG2 **Profile 1** (0x00000101 BASE) OR **Profile 4** (0x00000104 Medium lossy/lossless arithmetic) of [t.89]. Consumers MUST support both **Profile 1** and **Profile 4**.
- All Consumers MUST support at least "Level 2" Memory (See [t.89], Table 1, Item 18).
- The Producer MUST adhere to the Function and Memory constraints as specified in [t.89].

3.3.5 'DCTDecode' Filter

See http://partners.adobe.com/asn/developer/acrosdk/docs/filefmtspecs/PDFReference.pdf[pdf] Section 3.3.7, [ps-jpeg], [ps], and [jpeg]. PDF/is supports both the JPEG Baseline DCT and Extended sequential DCT compressed image formats.

Table 3-10: DCTDecode Filter

Field	Specification
<All Details>	AS SPECIFIED, except as noted below.

- Images MUST NOT be encoded using 'Progressive JPEG'.
- Images MUST have either 1 or 3 color components.
- All 3 component images (RGB, or YUV) MUST be 'interleaved'. See [jpeg] Section 4.8.1.
- The Consumer MUST adhere to the Memory requirements specified in Section 11 "RAM Requirements" of [ps-jpeg] for the Consumers Supported image resolution(s).

3.3.6 File Trailer

See [pdf] Table 3.12.

Table 3-11: File Trailer

Field	Specification
'Size'	AS SPECIFIED
'Prev'	PROHIBITED
'Root'	AS SPECIFIED
'Encrypt'	AS SPECIFIED
'Info'	REQUIRED.
'ID'	REQUIRED. MUST use a pseudo-random number in place of 'File Size' when generating this value. See [pdf] Section 9.3 for guidelines on how to generate this value. Rationale: Using a random number in place of file size is due to the requirements of using this field in generating the encryption key for the 'standard encryption' algorithm ([pdf] Step 5 of Algorithm 3.2, pg. 78): file size will not be known at the time this field is needed.

3.3.7 Encryption Dictionary

See [pdf] Table 3.13 and [pdf-ppk] Table 3.

Note that if a Document is Standard encrypted (Profile <STD-ENC>), the 'ID' field of the File Trailer MUST be calculated before the Encryption Dictionary is written. The 'ID' MUST then be cached until the 'File Trailer' is written.

The specification of the Encryption object depends on which type of encryption is Implemented in the Document. See the appropriate table, below.

Table 3-12: Standard Encryption Dictionary <STD-ENC>

Field	Specification
'Filter'	MUST have a value of 'Standard'
'V'	MUST have a value of '2'.
'Length'	REQUIRED
'R'	AS SPECIFIED

'O'	AS SPECIFIED
'U'	AS SPECIFIED
'P'	AS SPECIFIED
'SubFilter'	PROHIBITED
'Recipients'	PROHIBITED

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476 **Table 3-13: PPK Encryption Dictionary <PPK-ENC>**

Field	Specification
'Filter'	AS SPECIFIED.
'V'	MUST have a value of '2'.
'Length'	REQUIRED
'R'	AS SPECIFIED
'O'	PROHIBITED
'U'	PROHIBITED
'P'	PROHIBITED
'SubFilter'	MUST be 'adbe.pkcs7.s4'
'Recipients'	AS SPECIFIED

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478 ### 3.3.8 Document Catalog

479 See [pdf] Table 3.16.
480
481 It should be noted that Page Attributes MUST NOT be Inherited (See [pdf] pg. 91) due to the
482 nature of the ordering of the objects in this format. Rationale: Since the parent object of a Page
483 object will not appear in the format until after the page, streaming of the data for a page that has
484 an inherited attribute would not be possible.
485

486 **Table 3-14: Document Catalog**

Field	Specification
'Type'	AS SPECIFIED
'Version'	AS SPECIFIED
'Pages'	AS SPECIFIED
'PageLabels'	IGNORED
'Names'	IGNORED.
'Dests'	IGNORED.
'ViewerPreferences'	IGNORED.
'PageLayout'	IGNORED.
'PageMode'	IGNORED.
'Outlines'	IGNORED.
'Threads'	IGNORED.
'OpenAction'	IGNORED.
'AA'	IGNORED.
'URI'	IGNORED.
'AcroForm'	REQ if <DIG-SIG>, PROH otherwise
'Metadata'	IGNORED.
'StructTreeRoot'	IGNORED.
'MarkInfo'	AS SPECIFIED., See below.

'Lang'	IGNORED.
'SpiderInfo'	IGNORED.
'OutputIntents'	PROHIBITED.
'Fis_header	MUST be an indirect object reference to the 'PDF/is object'.

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489 **3.3.9 Page Tree Nodes**

490 See [pdf] Table 3.17.

491 **Table 3-15: Page Tree Nodes**

Field	Specification
'Type'	AS SPECIFIED
'Parent'	AS SPECIFIED
'Kids'	AS SPECIFIED
'Count'	AS SPECIFIED
<All 'Page Object' Fields, see [pdf] Table 3.18>	PROHIBITED

492

493 If the Producer of a Document knows that the Document is being generated in reverse order (e.g.
494 the scanner is scanning the last page, first), this fact SHOULD be conveyed by reversing the
495 order of the 'Kids' objects from the order in which they appear in the Document. Rationale: This
496 would allow a Consumer that has random access to the Document (i.e. does not need to stream
497 the data) the ability to display the pages in the proper order.

498

499 **3.3.10 Page Objects**

500 See [pdf] Table 3.18.

501 **Table 3-16: Page Objects**

Field	Specification
'Type'	AS SPECIFIED
'Parent'	AS SPECIFIED
'LastModified'	AS SPECIFIED
'Resources'	MUST NOT be inherited
'MediaBox'	MUST NOT be inherited
'CropBox'	MUST NOT be inherited. If Present, the TrimBox MUST NOT extend beyond the boundaries of the CropBox.
'BleedBox'	AS SPECIFIED. If Present, the TrimBox MUST NOT extend beyond the boundaries of the BleedBox.
'TrimBox'	REQUIRED.
'ArtBox'	PROHIBITED.
'BoxColorInfo'	PROHIBITED.
'Contents'	AS SPECIFIED.
'Rotate'	MUST NOT be inherited
'Group'	PROHIBITED.
'Thumb'	IGNORED.
'B'	IGNORED.
'Dur'	IGNORED.
'Trans'	IGNORED.

'Annots'	IGNORED.
'AA'	IGNORED.
'Metadata'	IGNORED.
'PieceInfo'	IGNORED.
'StructParents'	IGNORED.
'ID'	IGNORED.
'PZ'	IGNORED.
'SeparationInfo'	PROHIBITED.
'Fis_NextPage'	REQUIRED: An Indirect Object Reference to the next 'Page' object or a 'Page Tree Node' if this is the last page.

The size of the current page can be determined by the value of the 'MediaBox'. The value associated with 'MediaBox' is an array of the coordinates of the page rectangle in default user space units (1/72 of an inch). An 8.5 X 11 inch page, oriented Portrait, would be:

/MediaBox [0 0 612 792]

3.3.11 Content Streams

See [pdf] Table 4.1. A conforming Consumer MUST be able to parse the Content Stream operators listed below, but only must be able to act upon the operators that are not listed as IGNORED.

All objects referenced from a Content Stream MUST appear in the Document in the same order they appear in the Content Stream.

Table 3-17: Content Stream Operators

Operators	Specification	Reference
'q'	AS SPECIFIED	[pdf] Table 4.7
'Q'	AS SPECIFIED	[pdf] Table 4.7
'cm'	MUST be [Sx 0 0 Sy Tx Ty], See Below	[pdf] Table 4.7
'Do'	AS SPECIFIED	[pdf] Table 4.34
'MP'	IGNORED	[pdf] Table 9.8
'DP'	IGNORED except for 'Tiling operator' and 'Cache operator', see below	[pdf] Table 9.8
'BMC'	IGNORED	[pdf] Table 9.8
'BDC'	IGNORED	[pdf] Table 9.8
'EMC'	IGNORED	[pdf] Table 9.8
'BX'	AS SPECIFIED	[pdf] Table 3.20
'EX'	AS SPECIFIED	[pdf] Table 3.20
<All elements between a 'BMC' or	IGNORED	[pdf] Table

'BDC' and an 'EMC'>		9.8
<All other Operators>	PROHIBITED	

516

517 **3.3.11.1 'cm' Operator:**

518 See [pdf] Table 4.7 for definition of 'cm' operator.

519 Given:

520 Wi = Width (X-direction) of the Image in inches.

521 Hi = Height (Y-direction) of the Image in inches.

522 Xi = Horizontal translation, in inches, from the left edge of the page to the left edge of the
523 image.

524 Yi = Vertical translation, in inches, from the bottom edge of the page to the bottom of the
525 image.

526 The edges of the page are defined by the Page Object's 'Media Box'.

527

528 The Producer MUST ensure that the following is true:

529 **Sx** = Wi * 72

530 **Sy** = Hi * 72

531 **Tx** = Xi * 72

532 **Ty** = Yi * 72

533

534 **3.3.11.2 'Do' Operator:**

535 **See [pdf] Table 4.34 for definition of 'Do' operator.**

536 If the <MASK> profile is not Implemented, there MUST only be one image (one 'Do'
537 operator) per page.

538 **Image Resolution Calculations**

539 Given:

540 Img = The 'Image XObject' associated with the 'Do' operator.

541 Cm = The current 'cm' operation in effect for 'Img'.

542 Wp = 'Width' field of 'Img'.

543 Hp = 'Height' field of 'Img'.

544 Sx = 'Sx' value of 'Cm'.

545 Sy = 'Sy' value of 'Cm'.

546

547 The following MAY be assumed by either the Producer or the Consumer:

548 (Wp * 72 / Sx) = The resolution, in the X-direction, of 'Img', in dots per inch.

549 (Hp * 72 / Sy) = The resolution, in the Y-direction, of 'Img', in dots per inch.

3.3.11.3 'DP' Operators:

See [pdf] Table 9.8 for a definition of the 'DP' Operator.

The only 'Marked Content' flags that are not ignored in a PDF/is Document are the 'Tiling Operator' and the 'Cache operator'.

3.3.11.3.1 'Tiling' Operator:

Tiling facilitates the creation of a complex series of images on a PDF/is page to a Consumer that may be memory constrained and unable to otherwise display the page. If the Producer of the Document is able to determine that the current page's image layering (or "masking") will violate the cache memory constraints of the Consumer; the Consumer MUST break up the current page into non-overlapping regions to be displayed ('Tiling') or free up resources using the 'Cache Operator' (see below). Tiling is specified in the content stream of the page.

Tiles have the following properties:

- All images or masks in the content stream in a particular 'Tile' do not overlay, and are not overlaid by, any images or masks in any other 'Tile'.
- An object that is referenced in the Content Stream of a particular 'Tile' MUST not be used in any other 'Tile' unless that object is 'cached'.

To indicate that a new 'Tile' is beginning, the content stream MUST contain the following operator syntax, exactly as shown:

/Fis_tile <</Fis_tile [X Y]>> DP

Where:
X: A 'Real Numeric Object' (See [pdf] Section 3.2.2) of the maximum X coordinate value that this tile will contain.
Y: A 'Real Numeric Object' of the minimum Y coordinate value that this tile will contain.
And:
All coordinate values are in the user space coordinate system (0,0 is lower left), at 72 units per inch, relative to the Page Objects 'Media Box'.

- Use of this feature implies that the <MASK> Image Profile is Implemented.
- All Tiles in the same "row" MUST have the same **Y** value.
- All Tiles in the same "column" MUST have the same **X** value.
- A value of '0' for either **X** or **Y** implies that this Tile covers the remainder of this row or column, respectively.
- Tiles may only progress from left to right, top to bottom: the first tile is in the upper left corner (lowest X coordinate, highest Y coordinate), the last tile will be in the lower right corner.
- The last Tile operator (having a value of [0,0]) MUST not be present, as the close of the Content Stream will indicate that the last tile is to be rendered.
- The extent of an image within a particular Tile MUST meet the following requirements:
    - Its left edge MUST have an x-coordinate value greater than or equal to the **X** value of the Tile to the left of the current Tile, or '0' if this is the first Tile in a row.
    - Its right edge MUST have an x-coordinate less than the **X** value of the current Tile.
    - Its top edge MUST have a y-coordinate value less than or equal to the **Y** value of the Tile above the current Tile, or '0' if this is the first Tile in a column.

- Its bottom edge MUST have a y-coordinate greater than the **Y** value of the current Tile.

See the following examples to help illustrate this feature.

For the examples, below:
N: [X, Y]
Where 'N' is the order in which the tile appears in the Content Stream.
'X' is the 'X' value of the Tile operator.
'Y' is the 'Y' value of the Tile operator.

Example #1: an 8.5" X 11" page (612x792 units), divided into 9 equal sized Tiles:

1: [204, 528]	2: [408, 528]	3: [0, 528]
4: [204, 264]	5: [408, 264]	6: [0, 264]
7: [204, 0]	8: [408, 0]	9: (No operator)

Example #2: and 11" X 17" page (792x1224 units), divided into 4 "bands":

1: [0, 918]
2: [0, 612]
3: [0, 306]
4: (No operator)

A 'Tile Operator' MUST only occur between displayed images on a page, and MUST NOT occur at the beginning and/or end of the content stream.

To illustrate what a 'Tiled' content stream might look like; here is the content stream for Example #2, above:

```
stream
q
792 0 0 306 0 1224 cm  % region of first 'tile'.  792 units wide, 306 units high,
/Im1 Do                % Display image in first band.
/Fis_tile <</Fis_tile [0 918]>> DP      % 'Tile Operator'
Q
q
792 0 0 306 0 918 cm
/Im2 Do                % Display image in second band.
/Fis_tile <</Fis_tile [0 612]>> DP
Q
q
792 0 0 306 0 612 cm
/Im3 Do                % Display image in third band.
/Fis_tile <</Fis_tile [0 306]>> DP
Q
q
```



```
792 0 0 306 0 306 cm
/Im4 Do                 % Display image in last band.
endstream
```

3.3.11.3.2 'Cache' Operator:

The 'Cache Operator' allows the Producer of the Document to specify that certain 'cached' objects (See 'Cached Objects' section in this specification) may be released from the cache at a certain point in the content stream. See 'Cache Release' section in this document for use of this operation. This operation would allow a Consumer to Discard specified objects to free resources for image operations. This operator has the following syntax:

/Fis_cache <</**Fis_cache** [OBJECTS]>> DP

3.3.12 Resource Dictionaries

See [pdf] Table 3.21.

The Resource Dictionary MUST reference all Image XObjects and ColorSpaces that are used on the current page. The position of the image objects, their masks, and color spaces with respect to each other is defined in the Image XObject section of this specification.

Table 3-18: Resource Dictionaries

Field	Specification
'ExtGState'	PROHIBITED.
'ColorSpace'	AS SPECIFIED.
'Pattern'	PROHIBITED.
'Shading'	PROHIBITED.
'XObject'	AS SPECIFIED.
'Font'	PROHIBITED.
'ProcSet'	IGNORED.
'Properties'	IGNORED.

3.3.13 ICCBased Color Space

See [pdf] Table 4.16.

Table 3-19: ICCBased Color Space

Field	Specification
'N'	MUST have a value of either '1' or '3'.
'Alternate'	PROHIBITED, Implies '/DeviceGray' if 'N' is '1' or '/DeviceRGB' if 'N' is '3'.
'Range'	AS SPECIFIED.
'Metadata'	AS SPECIFIED.

The following rules MUST be adhered to:

- All ICC profiles MUST adhere to ICC specification ICC.1:1998-09 [icc] and it's addendum ICC.1A:1999-04 [icc-a].
- The **Device Class** MUST have the Signature of 'scrn'. See [icc] Section 6.1.4, Table 11.

- The **Color Space** MUST have a Signature of either 'RGB ', or 'GRAY'. See [icc] Section 6.1.5, Table 13.
- The **Profile Connection Color Space** MUST have a Signature of 'XYZData'. See [icc] Section 6.1.6, Table 14. Rationale: The **XYZData** Profile Connection Space does not require an **AToB0Tag** which would increase the size and complexity of the profile, dramatically.
- The **Flags** at Bit Positions 0 and 1 MUST both be set to TRUE. See [icc] Section 6.1.8, Table 16.
- **Rendering Intent** MUST be IGNORED by the Consumer in favor of the 'Intent' field in the Image XObject. See [pdf] pg. 192 and [icc] Section 6.1.11, Table 18.
- **N-Component LUT-Based Input Profiles** are PROHIBITED. See [icc] Section 6.3.1.3.
- **FlateDecode** Filter compression MUST NOT be used on the profile data. Rationale: since the profile data must be cached on the target system in uncompressed form, so that it may be accessed during image processing; compression of this data will only affect data transmission. In addition, compression of this data may lead to an incorrect calculation of the cache memory required on the Consuming device.

Consuming devices that do not wish to support ICC color profiles MAY use the 'Alternate' color space as specified in [pdf] Table 4.16. It is strongly recommended that only devices with limited, or no color capability, or limited resolution (hand-held devices and the like) should consider not supporting ICC color profiles. Consuming devices that choose not to support ICC color profiles MUST support '/DeviceGray' and '/DeviceRGB' color spaces (See [pdf] pg. 179) instead and MUST interpret image color values using ICCBased color space's 'Alternate' color space definition.

3.3.14 Image XObjects

See [pdf] Table 4.35 for description of the following table.

Table 3-20: Image XObjects

Field	Specification
'Type'	MUST be 'XObject'
'Subtype'	MUST be 'Image'
'Width'	AS SPECIFIED
'Height'	AS SPECIFIED
'ColorSpace'	AS SPECIFIED, and see below.
'BitsPerComponent'	AS SPECIFIED
'Intent'	REQUIRED. The default SHOULD be 'Perceptual'
'ImageMask'	AS SPECIFIED
'Mask'	AS SPECIFIED, see below.
'SMask'	PROHIBITED.
'Decode'	AS SPECIFIED.
'Interpolate'	MUST be 'true'
'Alternates'	IGNORED
'Name'	IGNORED.
'StructParent'	IGNORED.
'ID'	IGNORED.
'OPI'	PROHIBITED.
'Metadata'	IGNORED.

- An ‘ImageMask’, if indicated in an Image XObject, MUST appear in the Document before the Image XObject that references it. Implementing an ‘ImageMask’ implies Implementation of the <MASK> Image Profile.
- The ‘ICCBased’ color space profile for an Image XObject MUST appear in the Document before the Image XObject that references it.
- All image data, no matter which image compression method is used, MUST be ordered as specified in Section 4.8.3 and in Figure 4.26 of [pdf], contrary to the ‘Note’ at the bottom of page 265 of [pdf].

3.3.15 Masked Images

See [pdf] Section 4.8.5.

Table 3-21: Masked Images

Field	Specification
<All Fields>	AS SPECIFIED

3.3.16 Interactive Form Dictionary

See [pdf] Table 8.47.

Table 3-22: Interactive Form Dictionary

Field	Specification
‘Fields’	MUST be an Array of one indirect object reference to an ‘Annotation Field Dictionary’.
‘NeedAppearances’	PROHIBITED
‘SigFlags’	MUST be ‘3’
‘CO’	PROHIBITED
‘DR’	PROHIBITED
‘DA’	PROHIBITED
‘Q’	PROHIBITED

3.3.17 Annotation Field Dictionary

See [pdf] Tables 8.10 & 8.49. This dictionary consists of entries from both a ‘Annotation Dictionary (Table 8.10) and a ‘Field Dictionary’ (Table 8.49).

Table 3-23: Annotation Field Dictionary

Field	Specification
‘Type’	MUST be ‘Annot’
‘Subtype’	MUST be ‘Widget’
‘Contents’	IGNORED
‘P’	IGNORED
‘Rect’	MUST be ‘[0 0 0 0]’
‘NM’	IGNORED
‘F’	IGNORED

'BS'	IGNORED
'Border'	IGNORED
'AP'	IGNORED
'AS'	IGNORED
'C'	IGNORED
'CA'	IGNORED
'T'	IGNORED
'Popup'	IGNORED
'A'	IGNORED
'AA'	IGNORED
'StructParent'	IGNORED
'FT'	MUST be 'Sig'
'Parent'	PROHIBITED.
'Kids'	PROHIBTED.
'T'	AS SPECIFIED.
'TU'	AS SPECIFIED.
'TM'	IGNORED.
'Ff'	MUST be '1'.
'V'	MUST be an indirect reference to a 'Signature Dictionary'.
'DV'	IGNORED.
'AA'	IGNORED.

722
723

724 3.3.18 Signature Dictionary

725 See [pdf] Table 8.60 and [pdf-ppk] Table 2.

726 The Digital Signature format MUST only be in the 'Raw Format', see [pdf-ppk] Section 2.2.

727 **Table 3-24: Signature Dictionary**

Field	Specification
'Type'	MUST be 'Sig'
'Filter'	AS SPECIFIED.
'SubFilter'	MUST be 'adbe.x509.rsa_sha1'
'Name'	AS SPECIFIED.
'Reason'	AS SPECIFIED.
'Location'	AS SPECIFIED.
'M'	AS SPECIFIED.
'ByteRange'	PROHIBITED (Implies all bytes in the Document with the exclusion of the bytes represented by the value of the 'Cert' field. See [pdf] for this field)
'Contents'	AS SPECIFIED.
'Cert'	AS SPECIFIED.
'R'	AS SPECIFIED.
'V'	AS SPECIFIED.
'ADBE_Build'	AS SPECIFIED.
'ADBE_AuthType'	AS SPECIFIED.
'ADBE_PwdTime'	AS SPECIFIED.

728

729 **3.3.19 Document Information Dictionary**

730 See [pdf] Table 9.2.

731 **Table 3-25: Document Information Dictionary**

Field	Specification
<All Fields>	AS SPECIFIED

732

733 ## 3.4 Object Lifetime

734 Some Consumer's may be limited in the amount of storage they may have to cache the
735 Document as it's received from the Producer. This storage limitation may prohibit the Consumer
736 from holding the entire Document before beginning to render the first page. To facilitate this
737 storage constraint, PDF/is has a mechanism of "object lifetime". This mechanism defines how
738 long an object must be held in storage before it is no longer needed.
739
740 If a Document can be fully maintained in the Consumer's storage, i.e. the Consumer is a PC or
741 some other device with large quantities of storeage; the Document's Cross-Reference table
742 should be used to access objects as they are needed. In this case, the Consumer should follow
743 the parsing model as spelled out in the PDF Reference [pdf].
744
745 If a Document cannot be fully maintained within the Consumers storage or if it is uncertain if it will
746 be able to do so, the Document MUST be linearly parsed and the following parsing rules MUST
747 be adhered to:
748
749 1) Documents MUST be parsed in order, from beginning to end.
750 2) All non-IGNORED object data in the Document MUST be maintained in the Consumers
751 cache unless it falls into one of the following categories:
752 a. The object was a cached object and has been released from the cache.
753 b. The object was a non-cached 'Page-Relative Object' for a previous page.
754 c. The object was a non-cached object that was referenced by a previous "Tile".
755 d. The object is the last 'Image XObject' for the current "Tile".
756 e. The object is an 'Image XObject' for the current page, and the page is not "Tiled".
757

758 ## 3.5 Cached Objects

759 If a 'Page-Relative' object MAY be used on more than one page or in more than one 'Tile', it will
760 be necessary to specify the object as 'Cached'. This will allow an object to be used throughout
761 the Document that otherwise would be discarded. This caching mechanism only applies to
762 'Page-Relative' 'Dictionary Objects'; see [pdf] Section 3.2.6.

763 An object that is held in the Consumers cache by the 'Cache Hold' mechanism MUST be
764 maintained in the cache until one of the following conditions is met:

765 • The 'Cache Release' mechanism is invoked for this object.

766 • The 'Cache Operator' is invoked for this object.

767 • The 'Document Catalog' is reached.

3.5.1 Cache Hold

To specify that an object should not be discarded once the current page is rendered, the Dictionary Object to be 'cached' should have the following array object added:

```
/Fis_Cache []
```

3.5.2 Cache Release

To release an object from the Consumer's memory; the following array object MUST be placed in the 'Page Object' of the first page in which the object is no longer needed. For example, if the object is question was first found on page 1 and was last used on page 3, the 'Cache Release' should occur in the 'Page Object' for page 4.

```
/Fis_Cache   [OBJECTS]
```

Where:

OBJECTS: is an array (contained in '[]'s) of indirect object references to the objects that were previously cached and are no longer needed. Indication of an object number that was never cached MUST be ignored.

Example:

```
3 0 obj
<<
/Fis_Cache []                    %First object to be cached.
…
>>
endobj
…
7 0 obj                          %Second object to be cached.
<<
/Fis_Cache []
…
>>
endobj
…                                %One or more Page objects in between.
45 0 obj
<<
/Type /Page                      %Page object
/Fis_Cache [3 0 R 7 0 R]         %Objects 3 and 7 are no longer needed.
. . .
>>
endobj
```

4 Conformance Requirements

This section specifies the conformance requirements for Consumers and Producers.

4.1 Producer conformance requirements

In order to conform to this specification, a Document Producer:

1. MUST specify the version of PDF (See [pdf] Section 3.4.1) as being 'PDF 1.4'.
2. MUST place the 'PDF/is' object as the first object in the PDF.

3. MUST place any ‘Encryption Dictionary’ object as the second object in the PDF/is Document, if the Document is encrypted.

4. MUST NOT include any private ‘PDF Name Registry’ values/objects (See [pdf] – Appendix E) that affect printed output.

5. MUST place the objects: ‘Interactive Form Dictionary’, ‘Field Dictionary’ and ‘Digital Signature’ object as the last three objects (in that order) in the Document, if the Document is Digitally Signed. Note that in a situation where the Consumer cannot cache the entire document before rendering, the detection of a valid or invalid Digital Signature will only occur after rendering of the entire Document.

6. MUST ensure that there is at least one Forward-Reference to each object. The only object that does not have to follow this rule is the ‘PDF/is Object’. Rationale: This will aid the Consumer with knowing which objects will need to be cached and which can be ignored.

7. MUST ensure that all objects appear in the PDF AFTER the object in which they are first referenced (Satisfied by Requirement 6) and BEFORE the next ‘Page Object’ unless the object is a Cached Object (See Section 3.4).

8. MUST ensure that all object identifiers ([pdf] Section 3.2.9) start at the beginning of a line.

9. MUST ensure that all ‘endobj’ keywords ([pdf] Section 3.2.9) start at the beginning of a line.

10. MUST ensure that all ‘stream’ data ([pdf] Section 3.2.7) does not contain a line beginning with the word “endstream”, aside from the required “endstream” that delimits the end of the stream.

11. MUST NOT Linearize the Document. See [pdf] Appendix F.

12. MUST NOT Incrementally Update the Document. See [pdf] Section 3.4.5.

4.2 Consumer conformance requirements

In order to conform to this specification, a Document Consumer:

1. MUST Support all of the REQUIRED PDF/is objects.

2. MUST Interpolate images up or down in resolution, as required, to properly match the Documents image resolution(s) to the Consumer’s device capabilities.

3. MAY ignore all IGNORED objects that the Producer added to the PDF/is Document.

4. MUST abide by the “Object Lifetime” rules in Section 3.4 if unable to Cache the entire Document.

5. MUST terminate processing of the Document if it is detected that the Document has been incrementally updated (See [pdf] Section 3.4.5) as these Documents are PROHIBITED.

4.3 File Layout

Given that a Document is fully compliant with this specification, a PDF/is Document will, nominally, take on the following format:

Table 4-1: File Layout

	Object
A	'PDF/is' object.
B	Encryption Object (if Profile <STD-ENC> XOR <PPK-ENC>)
C	Document Information Dictionary
D	Page object for page 1
E	Resources for page 1
F	Content object for page 1
G	Color Space(s) for page 1
H	Image Mask(s) for page 1
I	Image XObject(s) for page 1
J	[Repeat D – I for all remaining pages, in order]
K	Document Catalog
L	Page Node(s)
M	Interactive Form Dictionary (if Profile <DIG-SIG>)
N	Annotation Field Dictionary (if Profile <SIG-SIG>)
O	Signature Dictionary (if Profile <DIG-SIG>)
P	File Trailer
Q	Cross-Reference Table (See [pdf] Section 3.4.3)

5 Issues

- None currently.

6 Sample PDF/is PDFs

The 'source' of the sample document in this section can be viewed with any text editor but should only be modified with a binary editor, as the stream data contained therein is not compatible with text editors. Comments on the format of the documents are contained within the documents themselves.

This sample is an unencrypted, unsigned, one page document. The page contains a 'CCITTFaxDecode' masked, 'DCTDecode' color foreground image with a 'FlateDecode' gray scale background image.

ftp://pwg.org/pub/pwg/QUALDOCS/SamplePDFax/base-03.pdf

7 Normative References

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9 Revision History (to be removed when standard is approved)

Revision	Date	Author	Notes
1	10/9/02	Rick Seeler, Adobe Systems	Initial version
2	10/23/02	Rick Seeler, Adobe Systems	
3	11/19/02	Rick Seeler, Adobe Systems	
4	11/22/02	Rick Seeler, Adobe Systems	
5	12/19/02	Rick Seeler, Adobe Systems	
6	2/19/03	Rick Seeler, Adobe Systems	

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13 Appendix A

13.1 Intellectual Property Statement – Adobe Systems Incorporated

The following statement is in addition to the Intellectual Property Statement in the PDF Reference (See [pdf] Section 1.4).

Patent Clarification Notice Specific to Use of PDF for IPP FAX Protocol

Adobe has a number of patents covering technology that is disclosed in the Portable Document Format (PDF) Specification, version 1.4 and later, as documented in PDF Reference and associated Technical Notes (the "PDF Specification"). Adobe desires to promote the use of PDF as the file format for a future, IPP FAX Protocol to be proposed, recommended, finalized and published by the IEEE Printer Working Group (the "IPP FAX Standard").

This Patent Clarification Notice is in addition to the permissions statement set forth in Section 1.4 of the PDF Reference which shall also apply to Adobe's contribution to the IPP FAX Standard.

Accordingly, Adobe agrees to provide a Royalty Free License to all Essential Claims solely for the purpose of implementing the IPP FAX Standard. Adobe and the IEEE Printer Working Group will identify and establish, within the final, published release of the IPP FAX Standard, a process whereby implementers of the IPP FAX Standard can request and obtain the above license.

No license shall be extended to those implementing only draft versions of the IPP FAX Standard.

A "Royalty Free License" shall mean a license that:

i) shall be available to all implementers of the IPP FAX Standard worldwide, whether or not members of the IEEE Printer Working Group;
ii) shall extend to all Essential Claims owned or controlled by Adobe and its Affiliates;
iii) shall not be conditioned on payment of royalties, fees or other consideration except as described in (iv) and (v) below;
iv) may be conditioned on a grant of a reciprocal license on identical terms to all Essential Claims owned or controlled by the licensee and its Affiliates; and
v) may include reasonable, customary terms relating to operation or maintenance of the license

relationship including but not limited to the following: choice of law, dispute resolution, and patent notices.

"Essential Claims" shall mean all claims in any patent or patent application, in any jurisdiction in the world, that (A) Adobe and/or its Affiliates own and (B) that would be necessarily infringed by implementation of the IPP FAX Standard. A claim is necessarily infringed hereunder only when a licensee can prove that it is not possible to avoid infringing it because there is no non-infringing alternative for implementing the required portions of the IPP FAX Standard. Existence of a non-infringing alternative shall be judged based on the state of the art at the time a licensee implements the IPP FAX Standard.

The following are expressly excluded from and shall not be deemed to constitute Essential Claims:

1) any claims other than as set forth above even if contained in the same patent as Essential Claims; and
2) claims that would be infringed only by
    a) portions of an implementation that are not required by the IPP FAX Standard
    b) enabling technologies that may be necessary to make or use any product or portion thereof that complies with the IPP FAX Standard but are not themselves expressly set forth in the IPP FAX Standard; or
    c) the implementation of technology developed elsewhere and merely incorporated by reference into the IPP FAX Standard.

For purposes of the Essential Claims definition, the "IPP FAX Standard" shall be deemed to include only architectural and interoperability requirements and shall not include any implementation examples or any other material that merely illustrates the requirements of the IPP FAX Standard.

An "Affiliate" of a first entity is a second entity that is controlled (greater than 50%) by, in control of, or under common control with the first entity.

